

Progress in TC forecast at ECWMF

2021 TC forecast performance

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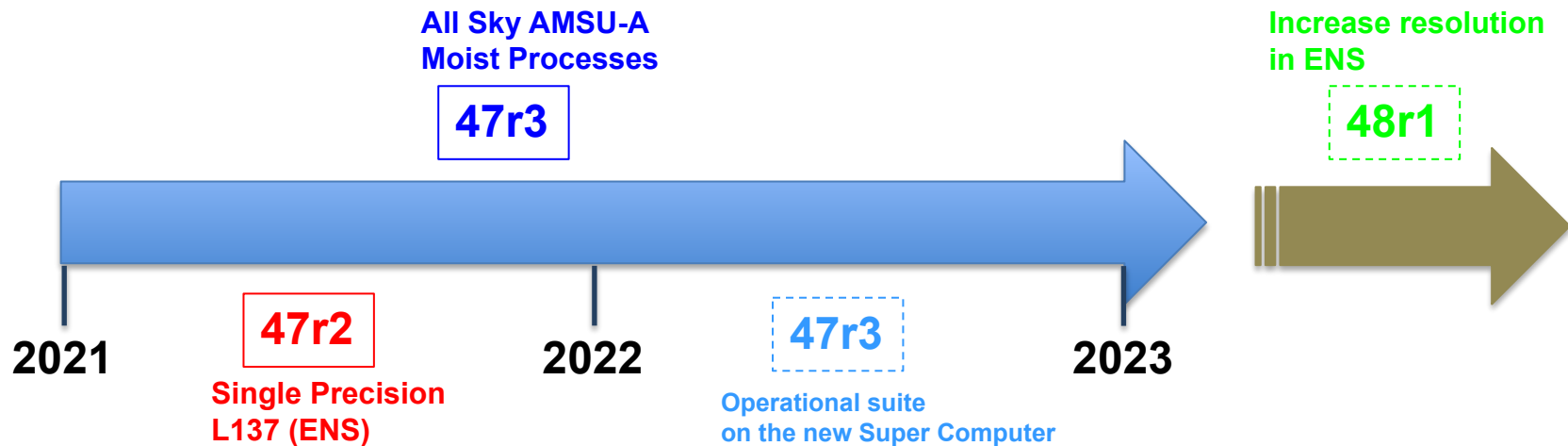
Evaluation Section, Forecast Department

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Outline

- **TC forecast performance 2021**
- **IFS model cycle 47r3**
 - **Key features**
 - **Meteorological impact (TCs, steer winds,...)**
- **IFS model cycle 48r1**
 - **Configuration**

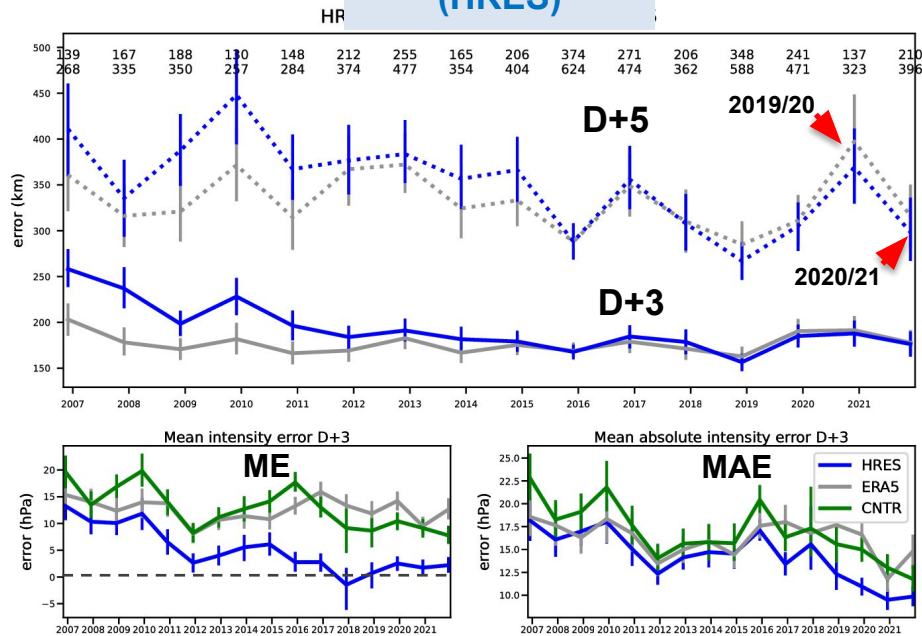
Recent model upgrades



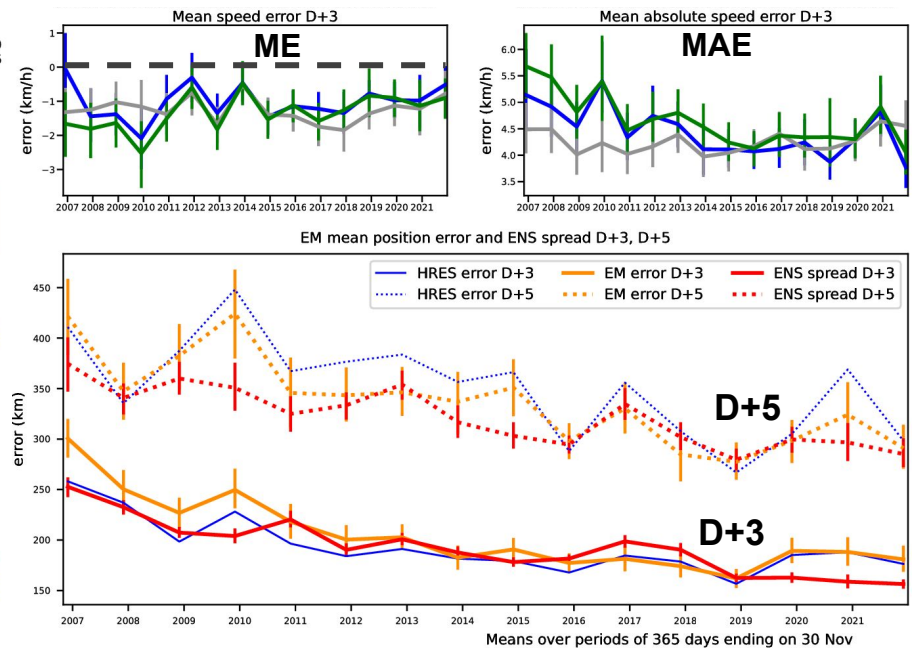
Tropical cyclone verification: HRES, ENS, ERA5

Model cycles 47r1 & 47r2 (HRES & ENS); 41r2 (ERA5)

Position
(HRES)



Speed



Central
pressure

Annual mean
From Dec (year) to Nov(year+1)

Position
(ENS)

TC position errors – All Basins VT: 20201201 to 20211130

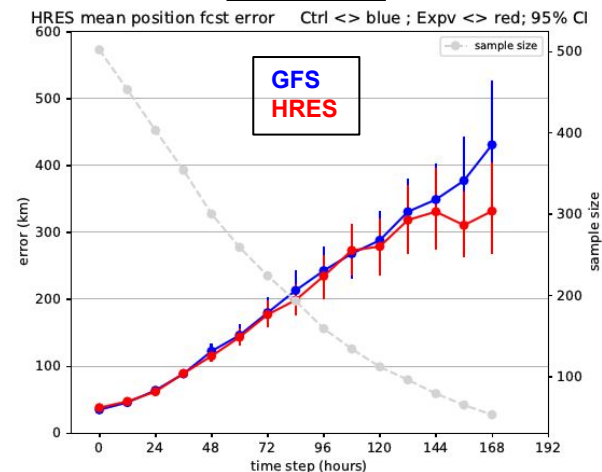
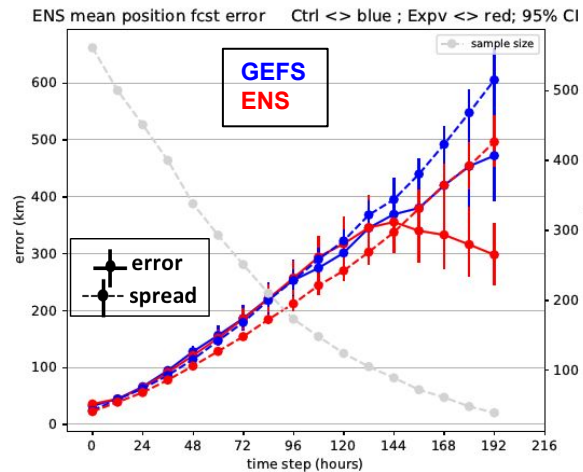
homogeneous samples

(47r1 & 47r2)

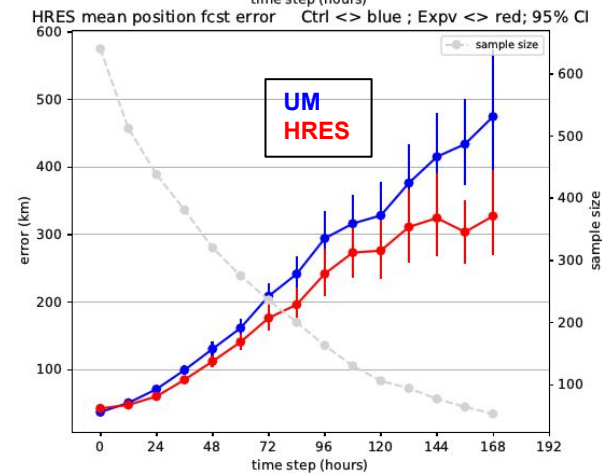
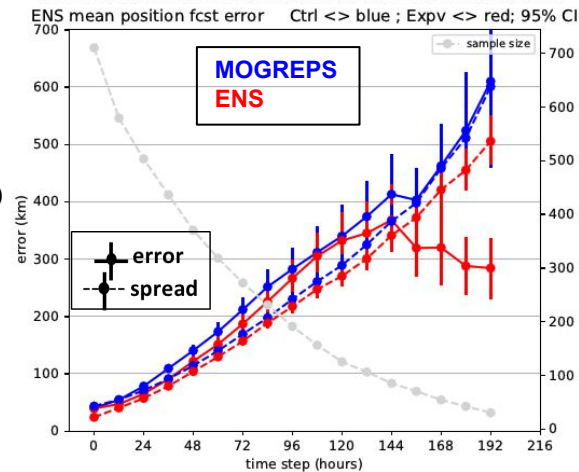
ENS Mean Error & Spread

HRES

ECMWF vs NCEP

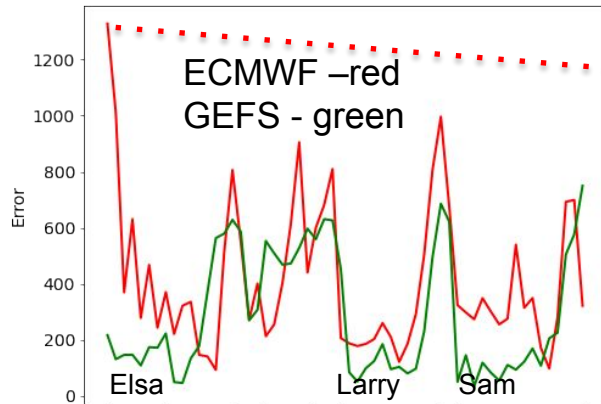


ECMWF vs UKMO



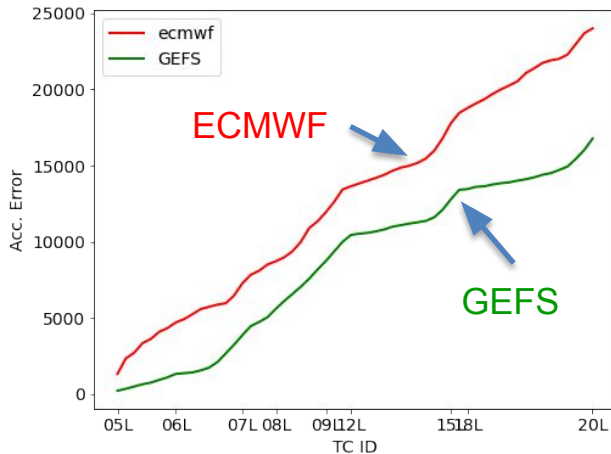
Ensemble mean error distribution day 5 (EC vs NCEP)

Errors for individual named storms

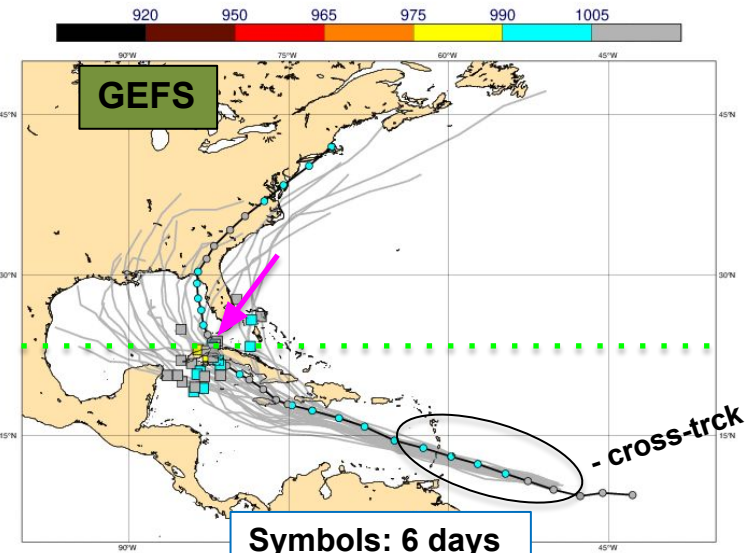
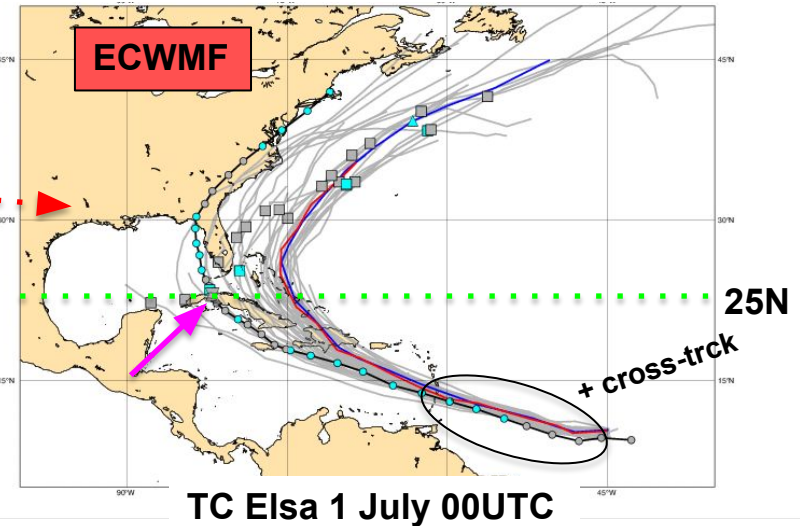


Wins
GEFS - 46
ECMWF - 12

Accumulated error since start of the season



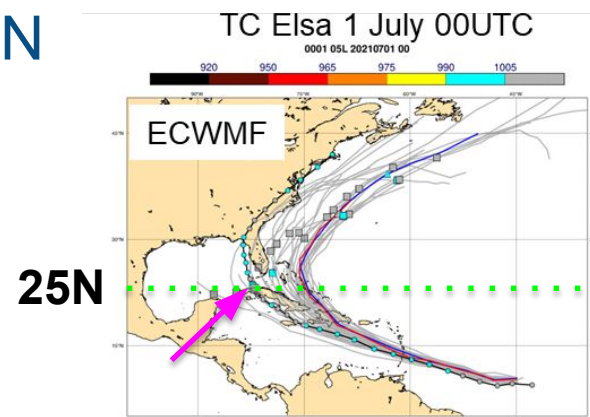
TC in 25% of members
needed to be included
here



Symbols: 6 days
into the forecast
VT:07 July 2021

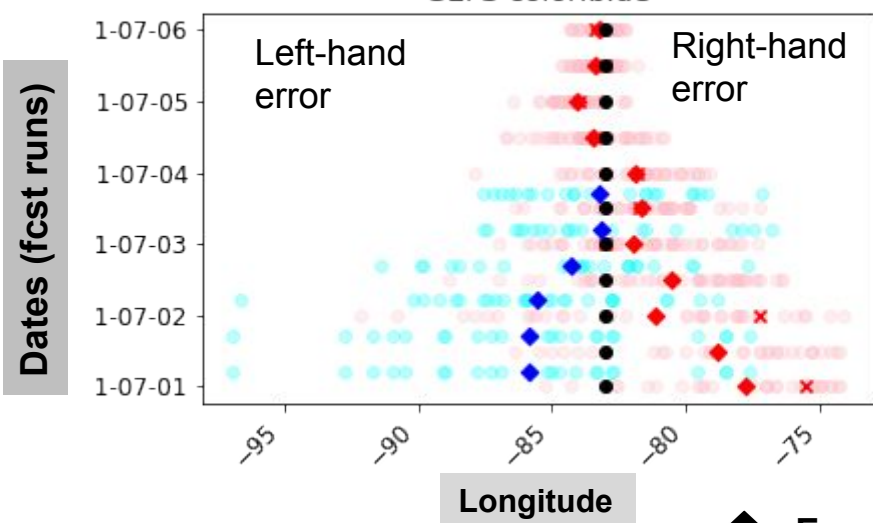
Ensemble - Longitude for Elsa passing 25N

EC forecast runs tend to show a positive cross-track errors for Elsa



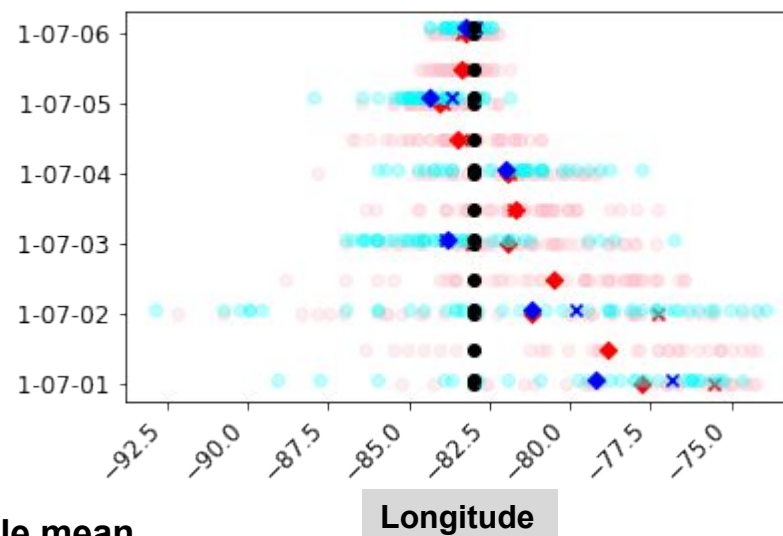
ENS (red) and GEFS (blue)

GEFS color:blue



47r2 (red) and 47r3 (blue)

0076 color:blue



◆ Ensemble mean
✕ HRES

Assimilation of all-sky AMSU-A in IFS cycle 47r3

Satellite	Launch	EOL	Broken Channels
NOAA-15	1998	-	6, 11, 14
NOAA-16	2000	2014	8, 9
NOAA-17	2002	2003	N/A
Aqua	2002	-	1, 2, 5, 6, 7, 14
NOAA-18	2005	-	8, 9
Metop-A	2006	2021	7, 8
NOAA-19	2009	-	7, 8
Metop-B	2012	-	15
Metop-C	2018	-	-

AMSU-A channels 5 to 14 are actively assimilated. These are channels with primary sensitivity to temperature from the mid-troposphere through upper stratosphere

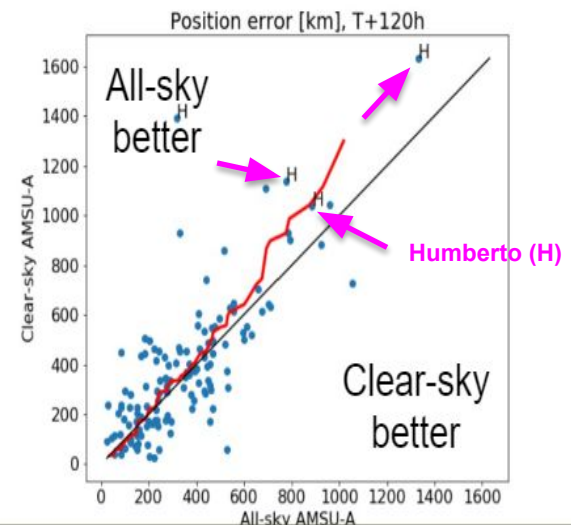
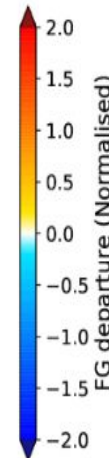
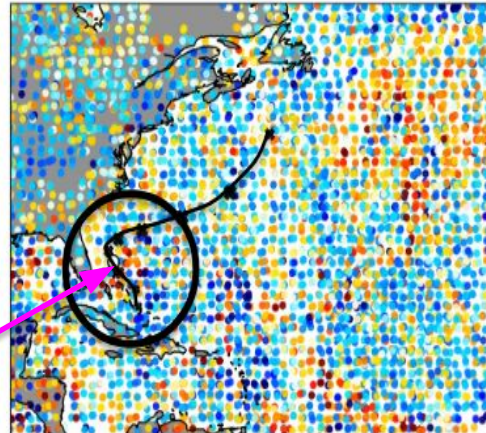
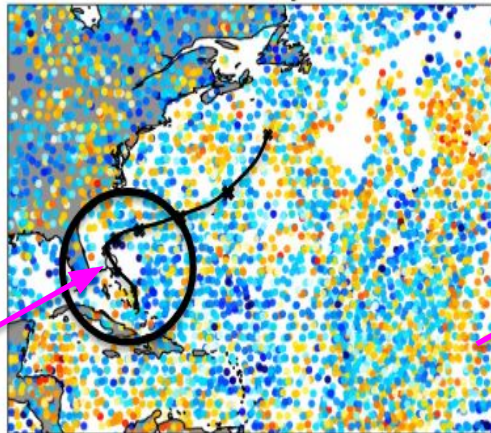
In 47r3, **“clear-sky” assimilation is replaced by “all-sky”**, treating satellite radiances in all atmospheric conditions

Clear-sky

08L Hurricane Humberto

15Sep 2019

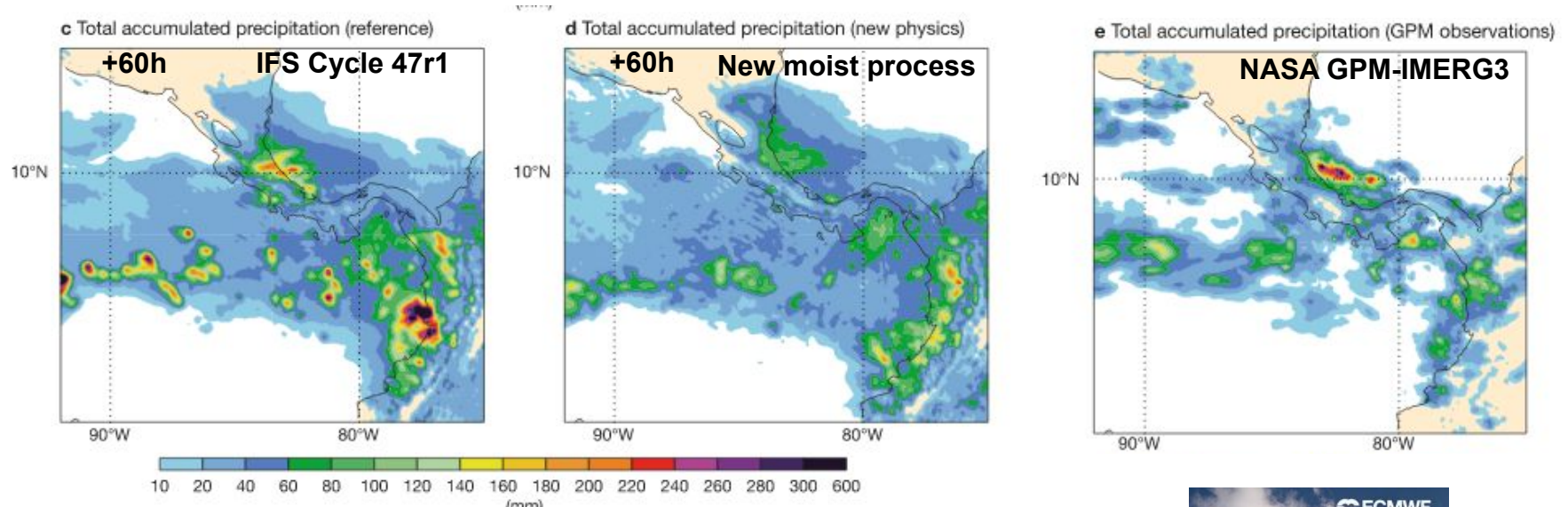
All-sky



- ➔ Assimilation of all-sky AMSU-A: Increases use of microwave sounder data in areas of cloud and precipitation (+12% global increase for Channel 5)
- ➔ Provide critical observations near Tropical Cyclones (example: Hurricane Humberto)

Moist physics upgrade in IFS Cycle 47r3

- Major development to moist physics parametrizations (cloud, convection, turbulent mixing, microphysics)
- Simpler interactions, more consistency, improved physical processes, better numerics

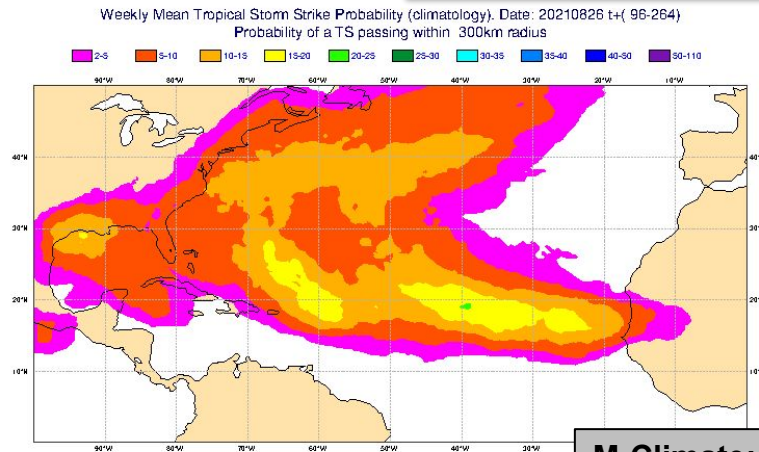
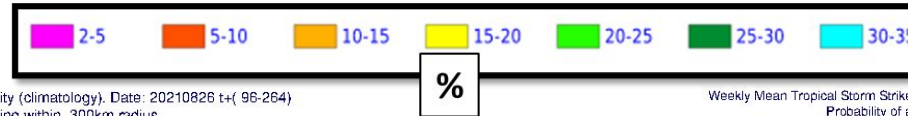
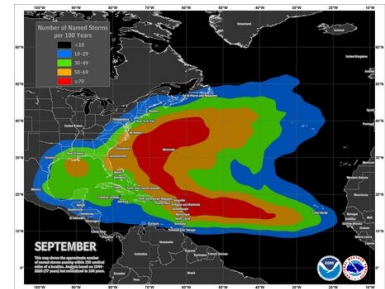


- the over activity of convective cells in ITCZ is reduced

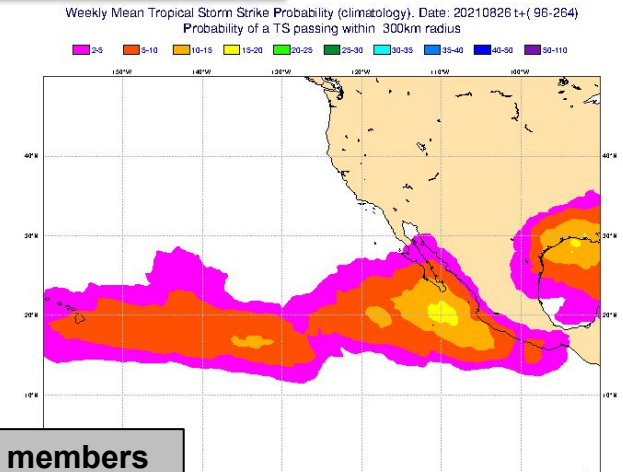
- ... Impact on the TC frequency (Model Climatology) in ATL & EPAC

Model Climate Tropical Cyclone Frequency

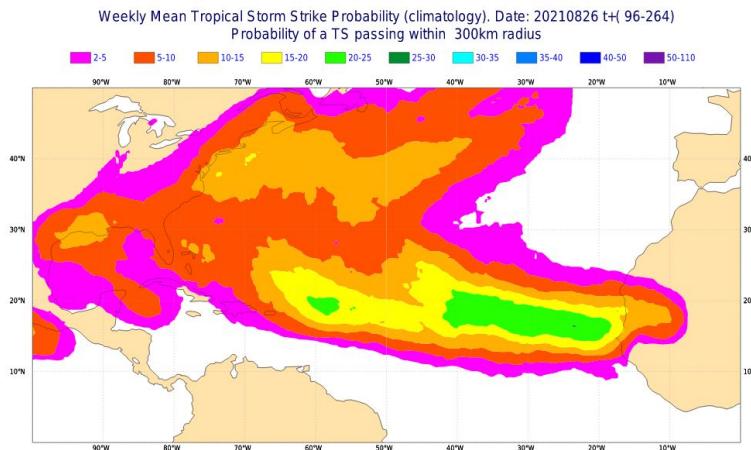
**M-Climate TS or HR (>34kts)
BT: 2021082600 +96h-240h**



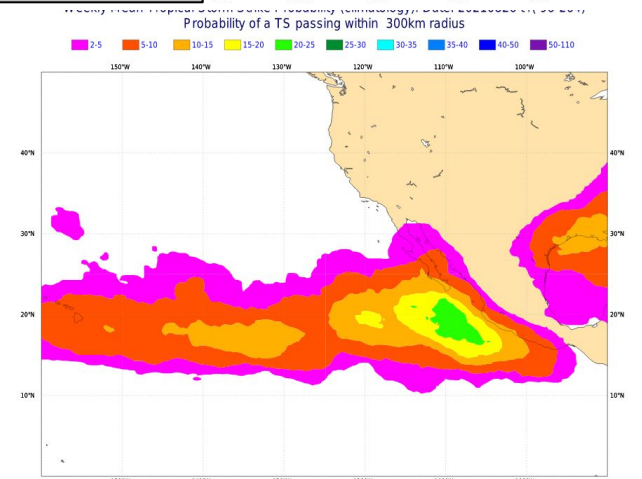
47r3



M-Climate: 20-years, 11 ENS members



47r2



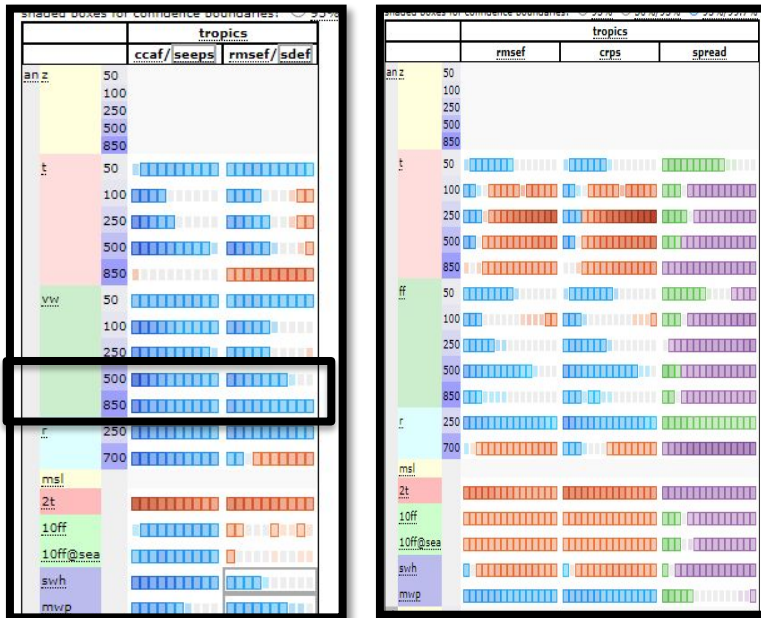
Meteorological Impact IFS cycle 47r3 – Scorecard

Tropics

HRES
AnomCorr /RMSE

ENS
CRPS

Forecast versus Analyses



red = 47r3 is worse than 47r2.

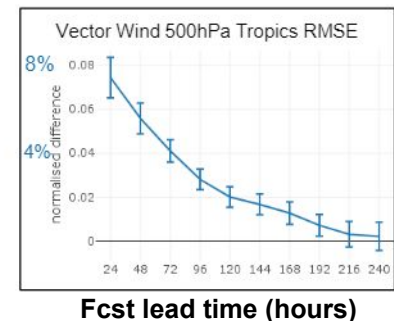
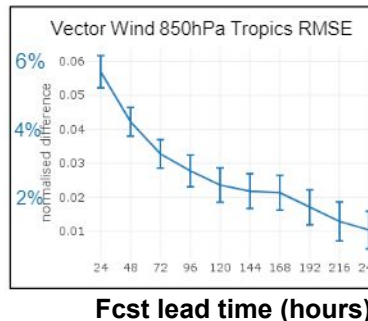
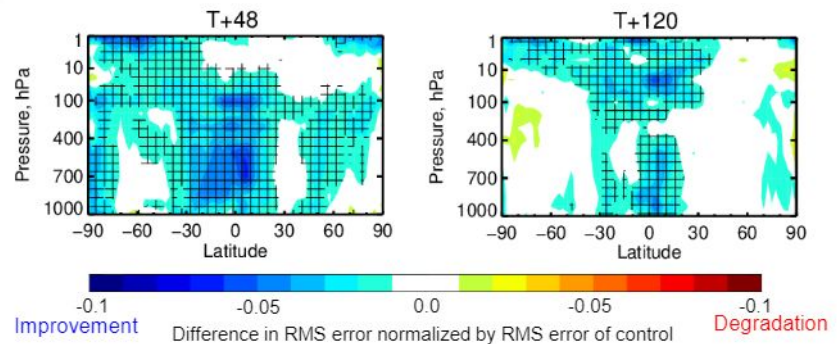
blue = 47r3 is better than 47r2.

purple = 47r3 is more active than 47r2

(2) Improved upper air - WIND

RMSE extratropics 1-2%, tropics 1-7% improvement

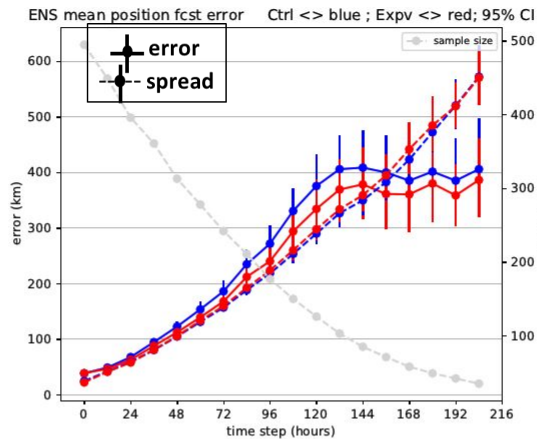
HRES Wind RMSE



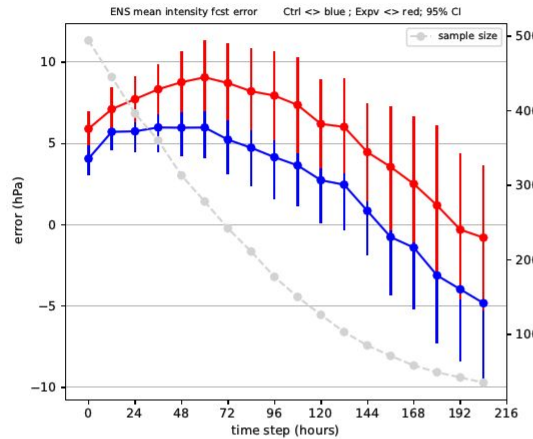
TC forecast performance comparison 47r3 & 47r2

All Basins
& homogeneous
samples

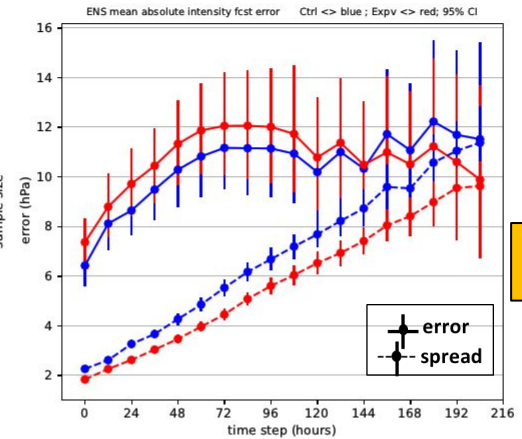
VT: 20201201-20211012
All Basins



pos fcst errors

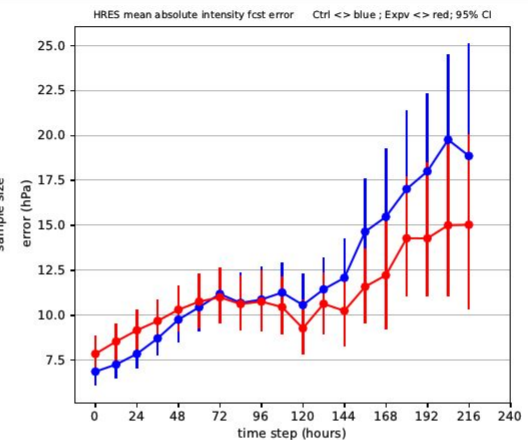
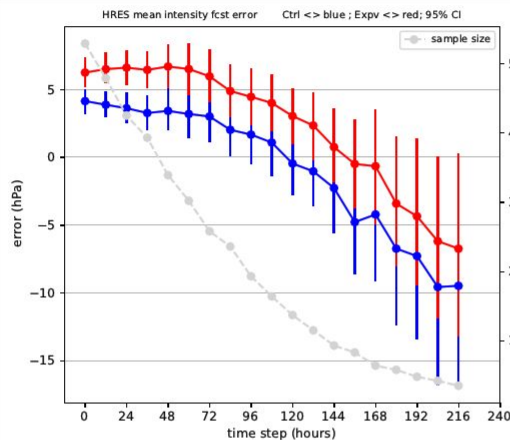
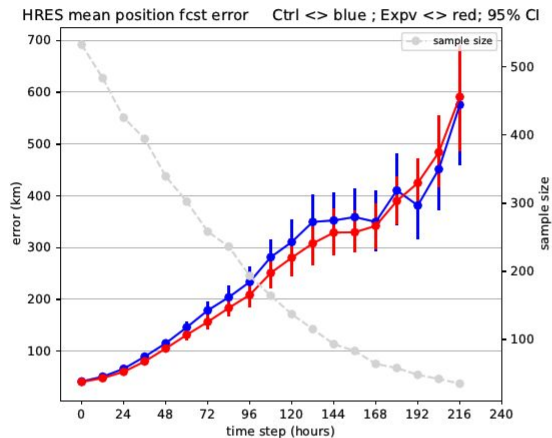


MSLP fcst errors (bias)



MSLP fcst errors (MAE)

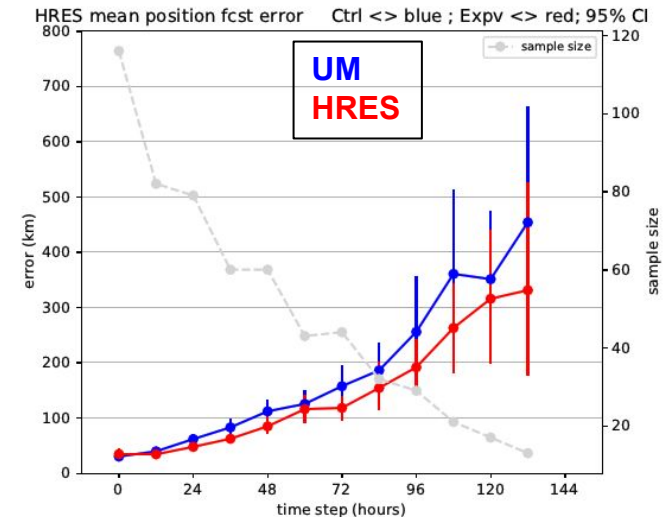
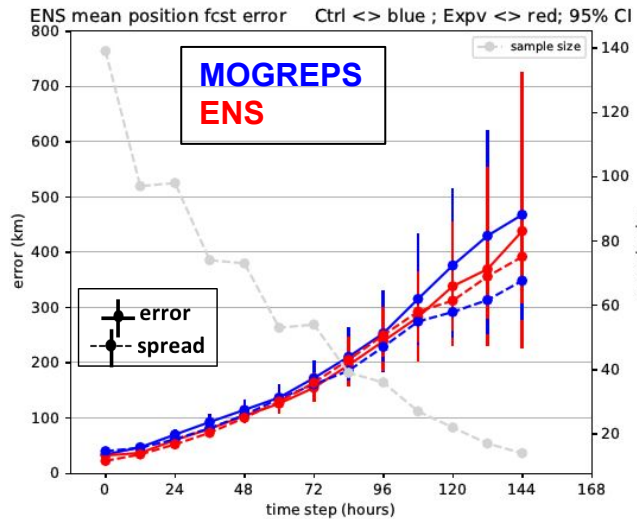
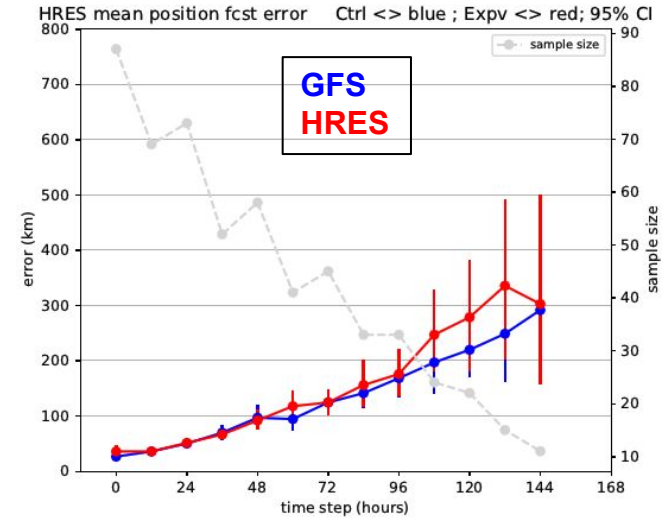
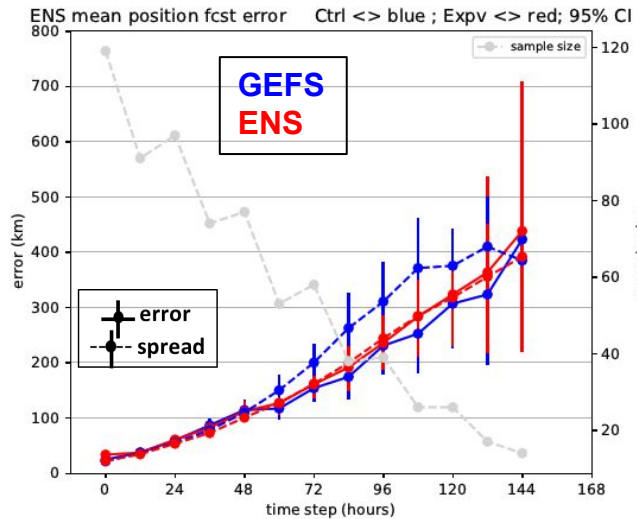
ENS
Error-spread



HRES

TC position errors – North Atlantic 2021 Season **47r3 only!**

All Basins
& homogeneous
samples



ENS Mean Error & spread

HRES

Next model cycles

- **Migration of IFS cycle 47r3 from Cray to Atos HPC (early summer 2022, from Reading, UK, to Bologna, Italy)**
- **IFS cycle 48r1 (Q1 2023)**
 - **ENS horizontal resolution increase (from 18 to 9 km) twice a day up 15 days**
 - **ENS Extended-range (46 days) to run daily (currently twice a week) with 100 ensemble members (lower resolution, 36 km) – becoming a separate system**
 - **Re-forecast configuration is unchanged (Mon & Thu 11-members, 20 years)**

Summary

- Two major model cycles upgrades in 2021
- 2021 Atlantic basin: larger TC position forecast errors compared with other Centres
- Globally: no degradation of HRES TC tracks against ERA5
- Cycle 47r3 impact on TC forecast: better TC tracks and weaker storms.
- Migration of the operational suite (47r3) to Atos HPC this summer
- Cycle 48r1 implementation in Q1 2023
 - ENS horiz. resolution increase (9 km)
 - Daily runs of the Extended Range (46 days) with 100 members at a lower resolution.